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# TRANSACTIONS

of the

# American Fisheries Society

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"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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# ON SOME QUANTITATIVE PHYSIOLOGICAL CHANGES IN THE PACIFIC SALMON DURING THE RUN TO THE SPAWNING GROUNDS

By Prof. C. W. Greene,

*From the Department of Physiology and Pharmacology, Laboratory of Physiology, University of Missouri.*

Among the anadromous fishes, the various species of Salmonoids are probably the largest and most important from an economic point of view. It is now well known (Evermann), that the Pacific salmon of the different species of the genus, *Oncorhychus*, after they reach maturity in the sea and make the run up the rivers to the spawning grounds in the cold fresh-water streams, invariably die after spawning. The Atlantic salmon, *Salmo salar*, and the Pacific steelhead, *Salmo gairdneri*, are supposed after spawning to return to the sea again for another period of feeding and development.

It is further well proven by the researches of the United States Bureau of Fisheries that the species of *Oncorhynchus* take no food during the run to the spawning grounds. The king salmon apparently ceases feeding upon entering the brackish waters in the region of the mouths of the rivers, and the long run against swift current and mountain torrents, amounting in the case of the Columbia River and its tributaries to as much as 700 to 1,000 miles, is made absolutely without food.

During my work I have found that many, if not the majority, of the individuals of the king salmon enter fresh water (at least in the Sacramento and the Columbia River basins) at a period when their reproductive organs are relatively immature. During the run from the mouths of the rivers to the spawning streams and the sojourn immediately following, the greater portion of the mass of the reproductive organs is developed. The two principal facts, namely (1), the expenditure of the large amount of energy without external food, and (2),

the development of one set of organs at the expense of material derived from other organs, form a unique biological experiment in nutrition. The experiment is unusually favorable also because of the fact that it is carried out in nature under conditions that must be assumed to be normal and natural for the animal itself. The source of the material from which is derived, first, the energy represented by the journey against the swift currents of the rivers, and second, the material used in the construction of the reproductive organs, forms the basis for the work of which the present brief report is only a small part.

This problem was attacked many years ago by Miescher, whose classic work on the Rhine salmon is well known. Later it was again resumed by Noel-Paton, working under the auspices of the Scottish Fishery Board and on the same species, *Salmo salar*. The Atlantic salmon, however, while it makes the run in fresh water without food, nevertheless is supposed to live to return to salt water where it again begins to feed. It remains to be seen whether or not the changes are as profound and as exhaustive as are found in the king salmon of the Pacific.

In 1906, after a series of preliminary studies extending through three summers, I made an exhaustive collection of samples of king salmon from the Sacramento River basin, California. This collection began with the sea-run fish caught while feeding at Monterey Bay and at Bolinas Bay, California. It included a series of samples taken from brackish water at Black Diamond on the Sacramento River, and closed with a similar collection from the spawning grounds of the McCloud River at the U. S. Fishery at Baird, California.

It is obvious that where marked changes are in progress in a series of animals upon which comparisons are drawn, some standard must be chosen as the basis of this comparison. In the case of the salmon the supposedly mature fish at the feeding grounds just before entering the fresh water is taken as a standard against

which are determined such changes as may have occurred in specimens from the stations at the head of brackish water and at the spawning grounds.

Noel-Paton has assumed the rule that similar solids are to each other as the cubes of similar dimensions. The dimension assumed to change least in the salmon is that represented by the length, i. e., the skeleton. If one assumes that the skeletal axis does not change in length while the various organs are being consumed in the migration, then the length measurement can safely be taken as the basis of comparison. My preliminary figures indicate that the method of comparison by the cubes of the lengths can not apply to the king salmon. Within narrow limits the variation in weight is closely proportional to the length. For the present illustration I have chosen salmon of nearly uniform lengths, thus eliminating the errors arising from computation. All have been reduced to the standard length of 860 millimeters.

A comparison of salmon from the three stations is made along two lines: First, as regards the changes in the gross amount of nutritive substances represented by the weight of the various organs; second, the change in the percentage composition of the primary chemical constituents of these same organs.

Unquestionably the muscle or flesh of the salmon forms the great store-house of nutritive material, especially of the fat. However, the skin, the liver, the digestive organs and probably the skeleton also serve as supplementary stores of energy-giving material. The figures representing these changes may be computed from two points of view. First, from the point of view of the intrinsic interest of a strictly scientific problem; second, from the point of view of the commercial, i. e., economic value of the food material represented by the salmon industry.

The individual fishes chosen are two females and one male from each station, namely, *the sea, the head of brackish water, and the spawning grounds of the Sacramento basin.* The comparison is made on the basis of

total length, i. e., from the tip of the nose to the base of the tail. The muscle or edible flesh, representing by far the greater volume of available nutritive material for either the fish or for man, is alone presented. The data include the length, weight, weight of muscle, total dry substance of muscle and certain percentage relations. The figures are represented in table I.

In table II it is seen that the average total weight is actually greater at the Black Diamond Station at the head of the brackish water, than at Monterey on the feeding grounds. The former fish are 11% heavier than the average Monterey standard. On the other hand, the Baird salmon have dropped in weight to 75% of the weight of the standard Monterey salmon.

The comparison above is made on the basis of total weight of the specimens. If the total weight of the muscle only is taken into consideration, the balance is still in favor of the Black Diamond salmon. The average weight is 7,220 gms. for the Black Diamond fish as against 6,836 gms. for the Monterey fish. This is an advantage of 105.6% so far as weight goes. At Baird the weight of the muscle has fallen to 3,311 gms. When the weight of muscle is taken in comparison with the total weight of the fish, however, it appears that the muscle of the Monterey fish weighs 67.8% of the total weight of the fish, the Black Diamond 64.4%, while the Baird specimens weigh 44.0%. These figures apply to the gross mass of the muscle.

When the total dry substance of the muscle is figured in per cent. of the total (wet) muscle then we have 38.3% for the Monterey fish, 35.7% for the Black Diamond, and 26.0% for the Baird. The weight of the dry muscle averages in the three cases, 2,616 gms. for the Monterey fish, 2,581 gms. for the Black Diamond fish and 682 gms. for the Baird fish.

These last figures, that is the percentage of dry muscle substance of the total muscle, and the total dry weight of muscle, bring out one striking comparison between the Monterey and Black Diamond fish. The point is

## TABLE I.

### Sacramento Salmon

Preliminary table exhibiting the basis for computation of the *commercial* and *food values* of the king salmon from 1. *salt water,* 2. *head of tide water,* and from 3. *the spawning grounds* in the Sacramento Basin.

| | | Actual Length & Weight | | Computed to standard length of 860 mm | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Locality collected | No. & Sex | Total length tip of nose to tip of tail mm | Total Actual weight gms. | Weight reduced to standard lenghth of 860 mm gms. | Weight of wet muscle gms. | Muscle % of total weight | Weight of muscle dry gms. | Dry muscle % of total weight | Weight of nutritive substance in % of total weight of standard sea fish |
| *Salt Water* | | | | | | | | | |
| Monterey Bay | 725 ♀ | 860 | 10,000 | 10,000 | 7,007 | 70.1 | 2,736 | 27.3 | |
| Monterey Bay | 705 ♂ | 860 | 10,100 | 10,100 | 6,554 | 65.0 | 2,458 | 24.4 | |
| Bolinas Bay | 754 ♀ | 906 | 10.700 | 10.150 | 6.906 | 68.0 | 2,625 | 25.8 | |
| *Average* | | 875 | 10.267 | 10.080 | 6.836 | 67.8 | 2,616 | 25.9 | 25.9 |
| *Head of tide water* | | | | | | | | | |
| Black Diamond | 875 ♀ | 878 | 10.550 | 10.330 | 6.643 | 64.3 | 2,219 | 21.5 | |
| Black Diamond | 877 ♂ | 860 | 11.150 | 11,150 | 7,426 | 66.5 | 2,710 | 24.3 | |
| Black Diamond | 879 ♀ | 928 | 13,000 | 12.050 | 7,584 | 63.0 | 2,813 | 23.3 | |
| *Average* | | 889 | 11,567 | 11,177 | 7,220 | 64.4 | 2,581 | 23.1 | 25.6 |
| *Spawning grounds* | | | | | | | | | |
| Baird | 946 ♀ | 878 | 7.650 | 7,493 | 3,023 | 40.3 | 562 | 7.5 | |
| Baird | 939 ♂ | 875 | 7,300 | 7,159 | 3.461 | 48.3 | 779 | 10.9 | |
| Baird | 938 ♀ | 915 | 8,450 | 7,942 | 3,449 | 43.4 | 704 | 8.9 | |
| *Average* | | 889 | 7,800 | 7,531 | 3,311 | 44.0 | 682 | 9.1 | 6.8 |

this, while the total mass of the muscle is greater, as was shown of the total body weight, yet the total mass of the dry substance has remained almost constant. In fact, the percentage of dry has dropped slightly, from 25.9% to 23.1%. This, along with the water determinations, shows that the *apparent increase in weight* of the Black Diamond fish over the sea forms at Monterey is not due to an increase by actual growth, but rather is *due to a taking on of water.* The substance of the dry muscle figured in per cent. of the total weight of the fish falls under that of the standard Monterey salmon by 2.8% as just shown. In the Baird salmon, the dry muscle is only 9.1% of the total fish. Furthermore, if these figures be converted into percentages of the standard weight for the particular lengths selected then they read: Monterey fish 25.9% of the standard, 25.6% for the Black Diamond fish, and only 6.8% for the spawners at Baird.

I have computed the percentage of dry substance of muscle without making any distinction as to the composition of the material. Of course, the actual nutritive value of the salmon flesh is found in the dry substance. This has been shown to decrease remarkably in the individual specimens during the migratory run. But when the chemical composition is taken into consideration it is obvious that the actual food value represented by the dry substance is found primarily in the fats. The fact is, the fat runs from 15% to 20% in the down river forms, but only 1% to 2% in the spawning ground salmon.

These three sea salmon of the table have an average of 15.6% of protein and 18% of fat in the muscle. At the head of brackish water the fat has already decreased somewhat both in percentage composition and in absolute amount. On the spawning grounds, in contrast with feeding sea salmon, the protein has dropped to 14.4% while the fat is almost entirely gone, 1.6%. See Table III.

One gram of fat represents a fuel value of over twice that of one gram of protein, i. e., 9,300 Calories for fat

## TABLE II.

### Sacramento Salmon

**A comparison of average values from the *sea*, the *head of tide water*, and the *spawning grounds*. Reduced to uniform standard length of 860 millimeters.**

| | | | | Wet Muscle | | | Dry Muscle | | |
|---|---|---|---|---|---|---|---|---|---|
| | Length | Weight | Percentage of standard weight | Weight of wet muscle | Percentage of standard weight of wet muscle | Percentage of standard fish | Weight of dry muscle | Percentage of standard weight of dry muscle | Percentage of standard fish |
| Sea | 860 | 10,080 | 100% | 6,836 | 100% | 67.8% | 2,616 | 100% | 25.9% |
| Tide water | 860 | 11,177 | 110% | 7,220 | 105.6% | 71.6% | 2,581 | 98.7% | 25.6% |
| Spawning grounds | 860 | 7,531 | 74% | 3,311 | 48.4% | 32.8% | 682 | 26.1% | 6.8% |

## TABLE III.

**Showing the protein and fat in percent of wet muscle:**

| Salmon number | Protein percent | Fat percent |
|---|---|---|
| 705 ♀ | 15.0 | 17.4 |
| 725 ♂ | 15.8 | 18.6 |
| 754 ♀ | 15.9 | 18.0 |
| Average | 15.6 | 18.0 |
| 875 ♀ | 16.7 | 12.4 |
| 877 ♂ | 17.1 | 15.1 |
| 878 ♀ | 16.8 | 16.3 |
| Average | 16.9 | 14.6 |
| 946 ♀ | 12.9 | 1.1 |
| 939 ♂ | 15.8 | 2.4 |
| 938 ♀ | 14.4 | 1.3 |
| Average | 14.4 | 1.6 |

and 4,100 Calories for protein. It is shown that the dry muscle substance in the Baird salmon muscle, which was only 6.8% by weight of the standard fish, is composed almost wholly of protein. The loss of the fat reduces the true nutritive or fuel value of the flesh of the Baird spawners to 2.3%, i. e., one-third of an equal weight of flesh from the standard salmon. In a word, the 6.8 dry pounds of apparent good food per hundred pounds of fish has dropped off two-thirds in quality.

To sum up this statement, the food material of the salmon stored in its muscles when it begins its run to the spawning ground is represented by 25.9% of the total weight of the fish, whereas at the end of the spawning run it is represented by about one-third of 6.8% or 2.3% of the total weight of the fish, a loss of between 84% and 85% of the stored material.

This material which is consumed from the muscles is supplemented by additional material from the skin, from the visceral organs, such as the stomach, intestines, pyloric caeca, and to some extent from the liver. The greatest changes in these latter organs are to be found in the visceral mass in which the weight decreases from an average of 265 gms. in the Monterey fish to 33 gms. in the Baird fish, i. e., one-eighth of the original amount. The weight of the liver, even in fish of the same length, varies extremely from all stations, hence no very reliable data can be derived from the study of this organ. The total weight of the skin and the viscera in fish from Monterey is in round numbers 400 gms. or about 4% of the fish weight. The absolute amount of nutritive substance furnished by these organs is small in comparison with that supplied by the muscles.

The disappearance of nutritive substance in these changes is to be accounted for, as was said in the beginning, by the expenditure of mechanical energy and by the growth of the reproductive organs. The distribution of materials as between these two factors is a most interesting story in itself.

# WHAT WE CAN DO TO PROMOTE FISH CONSERVATION

By Charles Minor Blackford, M. D.,
*Staunton, Virginia.*

Perhaps no country in the world possesses more societies and associations for the promotion of various ends than does the United States, and yet the small success that attends the labors of these organizations must attract the notice of anyone who looks into the matter. In every state, in many counties and in every city or large town, we find medical societies and other scientific or semi-scientific bodies that are trying to teach the people at large how to better their physical condition, and yet in many cases, their influence is negligible. It was only after the brilliant object lessons given by the altered hygienic conditions in Havana and on the Canal Zone, that the mass of our intelligent people became convinced that the mosquito is anything more than a trivial nuisance and that the house fly is a menace to life, although the medical societies had been preaching these facts to unheeding ears for several years. When the truth was brought home to the people, however, they grasped the situation, and the tables of mortality already show the results of the campaign now being waged against these domestic enemies.

The reason why these bodies of learned and experienced men have so small an influence on the people around them may be summed up in the single word, ignorance. This popular ignorance and its twin offspring, prejudice and vanity, must be overcome before any marked results can be effected. Mere legislation will not accomplish much. Along our special line, the conservation of fishes, there is ample legislation—indeed in some instances there is too much—but the legislation is not accomplishing its end and we should try to find out why it is not doing so. Many of the laws

on the statute books are not wise and would not accomplish anything if they were enforced, but the principal reason is lack of enforcement, and it is here that ignorance and its offspring, prejudice, come into play. One of the wisest of the writers on law has said that "He who knoweth the law and knoweth not the reason of the law, knoweth not the law; for the reason of the law is the life of the law," and we must teach the mass of the laiety the reason of the law if we wish to put life into the law and get hearty co-operation in its enforcement.

The greatest obstacle that we encounter in doing this is the vanity of the American people. For more than a century it has been a mark of so-called patriotism to claim that the resources of our country are inexhaustible, and anyone who called attention to the danger of extravagant wastefulness, was considered an hysterical alarmist or almost a traitor. In consequence of this foolish talk, we are now seeing the end of our forests, and geologists are estimating with alarming accuracy, the length of time that will elapse before our stores of iron and coal will be exhausted. National and state governments are frantically taking steps to check the ruthless destruction of these reserves of natural wealth before it is too late, but their efforts will bear scanty fruit unless the people be shown that the wonderful wealth of our country is not limitless. When this is grasped, and not until then, conservation will become an accomplished fact.

When America was first being settled by Europeans, the abundance and variety of the fisheries of both the salt and fresh waters made a deep impression on the colonists. The Grand Banks fisheries played no small part in causing the adjacent continental shores to be colonized, and the fishes along the coasts and in the rivers supplied the colonists with a large part of their food during the earlier years of the settlements. The widespread belief that this resource was inexhaustible led to such reckless destruction that the fisheries began to decline, and about the time of the Civil War the shad catch

had diminished to such an extent that its restoration was one of the main reasons for the establishment of the United States Commission of Fish and Fisheries, the predecessor of the present Bureau of Fisheries. Following the example of the National Government, many of the states have established commissions charged with the duty of restoring or increasing their respective fisheries, and it is a part of the duty of our Society to aid these commissions in the accomplishment of their task.

This can best be done by arousing the interest of the people in the work, and as said above, this can only be done by spreading abroad knowledge of the economic value of the fisheries and showing that in preserving them, something more is intended than merely restricting the rights of the fishermen. Our Society can do good work in this direction, both as individuals and as an organization, and I want to make a few suggestions as to how we may go about it.

At the meeting of the Fourth International Fishery Congress, held in Washington in 1908, O. M. Dennis, former State Game Warden of Maryland, gave some reasons for the failure of fish protective legislation, and among them he placed the selfish jealousy of sportsmen and commercial fishermen in regard to bills introduced by either class. He said that this being true, "The country members of the legislature, as well as the fishermen themselves, look with suspicion on any measure presented to the legislature which has for its purpose the protection of fish and game when such measure is presented by city men." Unfortunately this is true, and it is not confined to Maryland by any means. The antagonism between country men and city men is so widespread as to be almost universal, and among the rural population there is a general opinion that game protective laws are designed to furnish sport for city men at the expense of the rights of the country people. For this reason the game laws are very commonly looked on as something very much like acts of tyranny, and disobedience of them is regarded somewhat in the light of heroism. It should

be remembered that laws are but the crystallized expression of public opinion, and if there be no public opinion favoring a law, or if public opinion be opposed to a law, merely placing a legislative act on the statute book will not produce any result. It is therefore necessary to create an enlightened public opinion in favor of laws for the conservation of fishes, and when this is done the enforcement of the laws will be both easy and effective.

Our Society can aid in the development of this public opinion both as a collection of well informed individuals interested in this movement and as an organization. Our members come from many of the states of the Union, and among them are state and national officials, college professors, commercial fishermen, scientists and sportsmen; in brief, every aspect of the fishery question is represented among us. We are not sectional and we have no selfish nor class interests to serve, and consequently we are in better position to spread the knowledge of fish life among the people than would be any trade organization or even a purely scientific society. As individuals it would be well for us to write papers for the press; not merely for the big city papers, the sporting magazines and the fish trade journals, but for the country weeklies that go out among the masses of the rural population. If we were to write articles that are scientifically accurate; that are interestingly put, and above all, are not "in a tongue not understanded of the people," many of our members would be surprised to see how eagerly they will be read and what an effect they will produce. One of the main reasons that societies such as ours have so little effect on public opinion is that the subjects that we discuss and the language in which we discuss them are uninteresting and unintelligible to most of the people outside of our own narrow circle. It is hard for us, who have given much of our time and effort to the acquirement of a special line of knowledge, to appreciate that what is merely elementary to us is an unknown and fascinating world to many intelligent men outside of the ranks of professional naturalists. How many of these

people could tell how a fish egg is impregnated and how it develops? How many can tell anything of the life history of even the commonest fishes? The knowledge—if indeed it can be called knowledge—that most persons have of such subjects is a mass of traditional lore, resting on misinformation as a basis, that is so far from the truth that to call a tale a "fish story" is equivalent to saying that it is false. By putting the known facts of fish life clearly and accurately before the intelligent people of our country, we would make hundreds of practical students of the natural history of fishes where none are to-day, and nearly every one of them would become an active aid in the conservation movement.

Another method of advancing our purpose is to have our members give talks before school children. Many, if not all, of the school superintendents will welcome the chance of having some well-informed man or woman give one or more talks—we need not dignify them by calling them lectures—before the children on this subject, and by so doing the interest of the coming generation will be aroused. The recent Boy Scout movement offers another opportunity. Teach these boys how the black bass or the brook trout spawn; if possible show them some of the eggs during their development, and the boys will become ardent protectors of the spawning fish and not destroyers of them. They will see that the despised city sportsman is a pretty decent kind of fellow after all, and they will teach their parents and their neighbors the value of fish conservation.

Finally, what can we do as a Society to arouse greater interest in our avowed objects? We can take a hint from one of our sister societies, the National Geographic Society. We should remember that there is nothing in which any intelligent man is interested that may not be made an object of interest to any other intelligent man if it be properly put. We are far too prone to discuss technical matters that are of great interest to us as biologists and fish culturists, and to forget that these topics, although of great value, are of no interest to the

masses unless we try to make them such. At first glance it would seem that there are few subjects less interesting than the cold, bare facts of geography, but by putting these facts attractively, the National Geographic Society has built up one of the most entertaining magazines in the country, and has enrolled a membership of thousands. We might do something of the same sort. We might try to issue a magazine of popular ichthyology that would cover the scientific, the commercial and the sporting sides of our subject, and by having the articles written simply, clearly and accurately, spread the influence of our Society throughout the land. We would replace the ignorance and misinformation that now prevails by clear, concise and accurate knowledge, before which the obstinacies and prejudices that now oppose us would disappear. We would enlist thousands of eager students of all ages and sexes to battle for fish conservation, and we would make our Society a power in the land. Many of our members are easy and graceful writers, and I feel certain that enough of them would be willing to contribute articles to such a journal that would make it authoritative and valuable as well as interesting and entertaining, and, should the experiment succeed, we would have the consciousness of having performed a valuable service to our country.

# FISH PARASITES AND THE PUBLIC HEALTH

By Prof. Edwin Linton,
*Washington and Jefferson College, Washington, Pa.*

It had not been my intention to prepare a paper for the annual meeting of the American Fisheries Society this year, but certain recent happenings, of which the parasites of fishes were an important factor, suggest that I again discuss this question. Three years ago I presented a paper to this society on "Cestode Cysts in the Flesh of Marine Fish and their Bearing on Food Values,"* in which I fondly hoped, but vainly as it appears, that any fears which might have existed, either active or dormant, in the public mind respecting the effect of parasites in fishes used for food, would be dispelled.

In June, of the present year, the Department of Public Health of the City of New York condemned certain cargoes of butterfish amounting to many tons, thirty I have been told, on account of the alleged presence of parasites in the flesh. I was asked by the United States Bureau of Fisheries to have an interview with the New York health authorities concerning this matter of the butterfish. The interview was granted and held in the offices of the Department of Health for the City of New York on June 21, 1915. Previous to this interview I had supposed that the parasites to which objection had been made were the minute cysts of the cestode *Otobothrium crenacolle.* I had already discussed the bearing of this parasite on the food value of the butterfish in the paper cited above, and was prepared to give additional evidence of the harmlessness of this parasite even if eaten by man in his fish diet. I was much relieved therefore upon being assured by the officials that they had not objected to the butterfish on account of the cestode parasites. A new charge, however, was

*Trans. Am. Fish. Soc., for 1912, pp. 119-127.

brought against the butterfish, viz., that large numbers of them had nematode worms in the flesh.

Now, as it happens, I had examined large numbers of butterfish for flesh parasites in the past ten years and, having found their flesh free from nematode parasites I was not at all disposed to believe that butterfish had suddenly become parasitized in this way. I was familiar with the fact that nematodes are of common occurrence on the viscera, especially on the pyloric caeca, of the butterfish, an affiliction shared with the butterfish by many other species of fish to a greater or less degree, and suggested that nematodes seen on the viscera had been mistakenly referred to the muscle tissue. This created an issue, an *impasse* in truth, which could be resolved only by an investigation to see how the facts lay. Accordingly some butterfish were sent for and brought from the market. A fish was opened. Nematodes were found on the viscera, but none in the flesh except a few that had been carried thither by the knife used in opening the fish. The remaining fish were opened more carefully with the result that nematodes, so far as they were present at all, were found only on the viscera.

Detailed results of the examination of butterfish for nematode parasites are given below.

Before taking up the discussion of the particular case afforded by the butterfish I shall discuss briefly the general question of the effect on food values of the presence of representatives of different orders of helminths in food fishes. Preliminary to this, however, I shall ask indulgence for a few remarks on the general subject of parasites. The late Joseph Leidy, many years ago, made an interesting contribution to science in a paper entitled *A Fauna and Flora within Animals.* The title alone was a valuable gift to popular knowledge. That paper showed that there exist in nature large numbers of species of animals and plants which pass all, or an important part, of their existence within the bodies of animals. The indweller is called a parasite or guest; the animal which harbors the indweller is called the host.

The successful completion of the round of life of many of these parasites requires that the host which harbors one stage of the parasite be eaten by a host in whose alimentary canal the parasite will find conditions favorable for its further development. As a rule the number of species of animals which are fitted to become the final host, that is the host in which the parasite becomes adult and produces eggs, is limited. Thus in the case of the flesh parasite of the butterfish, although the butterfish is eaten by all the larger carnivorous fish that swim the waters with them, they develop only in the sharks, and in an exceedingly small number of species of shark. To make the question still simpler, it may be said that when a blue fish, for example, eats a butterfish that is harboring cestode cysts in the flesh, it utilizes as food the cestode cysts with their contents in the same manner and doubtless with equal benefit as follows the assimilation of a similar quantity of proteid material from the muscular tissue; while a hammerhead shark which eats a butterfish containing these cestode cysts in the flesh, instead of digesting the larva that will be liberated from the cyst, furnishes the proper conditions for that larva to develop, and he will have in a short time the adult cestodes in his spiral valve. There is no reason to believe that the butterfish cestode will develop in man; on the contrary there is very good reason to believe that it will not develop in any warm-blooded animal. Furthermore, all helminth parasites are killed in ordinary cooking and the tissues of which they are composed are doubtless as nutritious as are those in which they chance to be embedded. Again, the popular mind should be taught to discriminate between the animal and vegetable inhabitants of living animals and those which may make their appearance in the flesh of animals after they are dead. The latter, when they are the larvae of insects for example, that is maggots, create unpleasant sensations and suggest spoiled meat, or meat that has not been properly cared for; when bacteria, they are associated with the disturbing phenomena of putrefaction. In either case

food so infected is justly viewed with suspicion, and health authorities are remiss if they allow such conditions to exist.

It cannot be emphasized too strongly that insect larvae in meat, or putrefactive changes have nothing in common with cases of animal parasitism. The helminth parasite, in the alimentary canal particularly, or in the tissues of its host, in somewhat less degree, requires that the animal which harbors it be living. They do not, as a rule, long survive the death of the host. Living nematodes on the viscera of a butterfish in the market, therefore, are no indication that the flesh of the butterfish is not perfectly fresh and wholesome.

*Cestodes.*—I do not recall any cases of cestode parasites of fishes in this country which, like *Bothriocephalus latus*, found larval in certain European fishes, develop in man.* If such exist the habit of eating only cooked fish which prevails here precludes any possibility of man's becoming the final host. With the exception of the butterfish, the marine food fish that I have examined are prevailingly free from cysts in the flesh. In the butterfish a small cyst, about one millimeter in diameter is found. If the back-bone of a fish which has these cysts in the flesh be removed it will carry away with it practically all of the cysts, which, save in an occasional highly infected individual, are limited to the immediate vicinity of the back-bone, where they are, for the most part, lodged in the spaces between the vertebral spines above and below. On account of their small size and resemblance to small fish roe there is nothing unpleasant in the sight of these cysts, if they would be distinguished at all, an exceedingly unlikely event. As stated above there is no reason to think that these cysts can develop in man, or indeed in any warm-blooded animal. The New York health authorities are right in making no objection to the use of butterfish as food on account of cestode cysts in the flesh.

*It has been brought to my attention since this paper was written that *Bothriocephalus latus* has recently made its appearance in Wisconsin, where it has evidently been introduced from Norway.

It is not necessary to discuss the possibility of man's becoming the secondary host, that is of harboring cestode parasites in the encysted stage, as, even where such possibility exists, which is certainly not true in the case of the butterfish cestode, infection would not be incurred from using fish as food.

It is interesting to note that the percentage of butterfish having considerable numbers of cysts in the flesh has been diminishing in the Woods Hole region during the past six years. The percentages of butterfish with numerous cysts in the flesh for the years 1909-1914, inclusive, are 48, 29, 36, 15, 13, and 12; the smallest number of fish examined in any one year was 416, in 1910, and the greatest was 948, in 1912. The results of the examinations this year thus far show a rather marked diminution in the number of parasitized fish from that of last year.

*Trematodes.*—Fortunately trematode parasites are not at all common in fishes in situations which render them liable to be ingested with parts used as food. In marine food fish I have not found them in the flesh, although they often occur in small cysts on the skin and especially on the fins. They may be recognized as small specks of black pigment, sometimes, especially on the cunner and tautog, in large numbers. As fish are ordinarly prepared for the table, such encysted trematodes are removed. There is nothing unpleasant in the sight of these skin parasites, unless they occur in very great numbers, not a usual happening, and nothing is to be feared from them, so far as at present known, even if they be eaten uncooked. The natural final host of those whose life history has been made out is some fish-eating bird. Fishes in fresh water lakes are more liable to infection in this way than are the fishes of the sea.

*Nematodes.*—Parasites of this order are found in the alimentary canals of many species of marine food fishes, especially in some of the larger kinds, such as the swordfish, cod, haddock, etc. They are also found encapsulated

on the viscera of most species of fish, sometimes in large numbers. But in the flesh of food fish they are of infrequent occurrence.

While nematodes in food are not necessarily injurious, even if taken in uncooked food, there is a natural and justifiable prejudice against them as an article of diet. Certain of them, as is well known in the case of trichina of pork, may be inimical to health or even to life itself. That there should have been uneasiness, therefore, occasioned by the noticing of the presence of nenatodes in a food fish is not a thing to be marvelled at. But that the health authorities of New York did not inform themselves of the true nature of this case is regretable to say the least.

## ALLEGED OCCURRENCE OF NEMATODES IN THE FLESH OF THE BUTTERFISH.

Now what are the facts with regard to the occurrence of nematode parasites in the flesh of the butterfish? That they occur on the viscera and especially on and among the pyloric caeca is certain. That they were found in the flesh, except as they were carried there by the knife used in opening the fish, from which lodgement they would have been removed in washing the fish in preparation for the table, there is much more reason to doubt than to believe. The New York health authorities were requested to forward to the Bureau of Fisheries examples of butterfish containing nematodes in the flesh. In response to this request suspected fish were sent, but no nematodes could be found in their flesh.

Since my interview with the New York health officials I have gone over my notes of examinations of butterfish for flesh parasites with the following results: It should be noted in the first place that the butterfish which were examined for parasites in the flesh were examined for the purpose of making a record of the frequency of occurrence of cestode cysts. As the examinations were made a record was kept in columns with the headings: "No cysts seen," "very few," "few," "many," "numer-

ous," "very numerous." In order to determine to which column of the record the fish under examination should be referred, the fish, having been split open with a sharp knife inserted near the middle of the back, thus had the flesh of one side separated from the skeleton. In many cases only one or two cysts are found, and as these cysts are only about one millimeter in the longest diameter, careful attention had to be given in order to make the record as exact as possible. Now the nematodes which are of such common occurrence on the viscera of the butterfish are about 12 millimeters in length, and are, moreover, of a reddish brown color. They are therefore much more conspicuous objects than the cysts, which do not differ much in color from the muscles and bones with which they are associated. If nematodes were at all common in the flesh of the butterfish, therefore, they would most certainly have been detected in this search which began in the summer of 1904 and has been continued each season since. Most of the examinations were made in the months of July and August. These are supplemented by examinations made by Mr. Vinal N. Edwards in the months of May, June, September and October. The examinations were made on different dates throughout the season. Thus my record shows that in the season of 1912 there were 948 butterfish examined for flesh parasities on 23 dates in July from the 4th to the 31st, and on 10 dates in August from the 1st to the 23d. In 1913 butterfish were examined on 30 dates from June 30th to August 29th; in 1914, 785 were examined on 32 dates from July 10th to September 9th. Besides these I have records of examinations made by Mr. Edwards of 416 butterfish on 21 dates in May, June, September and October. The total number of butterfish which I have examined for flesh parasites in successive years from 1904 to the present time is 5,992; in the last eight years the smallest number for any one year is 416.

Mr. Edwards reports that he has found no nematodes in the flesh of butterfish. My own record of finds of nematodes in the flesh of butterfish is as follows: On

August 6, 1913, one nematode was found in the flesh of the side of a butterfish. It was 29 millimeters in length, much larger than those found on the viscera.

On July 14, 1915, one nematode was found in the flesh of a butterfish. The fish had been opened by another worker in the laboratory and had been lying for some time before I examined it. The length was 29 millimeters. It is a different species from that which is found on the viscera. Another nematode of the same species as the last was found in the flesh of the side of a butterfish on July 14, 1915. It was 32 millimeters in length.

These three nematodes make up the total found in the flesh of the butterfish to date. In each case they would have been detected without much doubt if the fish had been split open in preparation for the table. This record of three nematodes found in three butterfish out of nearly 6,000 butterfish examined especially for flesh parasites over a series of years is a very remarkable one. Very few of the species of animals used for food can show such a favorable record after having been subjected to such a rigorous test.

The occurrence of immature, encapsulated nematodes on the viscera, and especially on and among the pyloric caeca of the butterfish is common, but in this the butterfish is not exceptional. About 20% of the butterfish that I have examined this season have had many of these nematodes on the viscera; about 40% had none; the remaining 40% had few, often only one or two were found after very careful search. Fish were left unopened from one day to the next, and variously tested to see if the nematodes on the viscera showed any tendency to enter the flesh. None did so.

That there is nothing new or exceptional in the occurrence of nematodes on the viscera of butterfish is abundantly proved by records made in previous years. For example, in the Bulletin of the U. S. Fish Commission for 1899, p. 279, under the butterfish the following statement is made:

July 21, one—numerous nematodes on viscera. July 23, one—enormous numbers of immature nematodes on and among the pyloric caeca. August 10, three—serous coat of pyloric caeca with large numbers of immature nematodes. August 22, four—numerous small, immature nematodes found on pyloric caeca.

Also on p. 453 of the same volume the following statement under the butterfish is made:

Immature nematodes. Very abundant. Found in the majority of specimens examined in 1899 and 1900; small, pale red; particularly abundant on pyloric caeca—length 13 millimeters.

This record is introduced here to show that there is nothing in the nature of a seasonal epidemic in the occurrence of nematodes on the viscera of the butterfish. Further, it should be said, those who have given attention to the distribution of animal parasites could furnish just as impressive figures for many of the species of animals used for food.

A careful consideration of the facts above recorded will I am sure, convince any unprejudiced person that the New York health officials were mistaken in their supposition that the nematodes of the butterfish were in the flesh.

If there is any one who would allow my find of three small nematodes in the multitude of nearly 6,000 fishes to prejudice him against the use of an excellent food fish, he should not only beeome a vegetarian, but should make a microscopic examination of any fruit or vegetable salads, or mushrooms that may come on the table if he wishes to escape the possibility of an occasional nematode finding sanctuary in his fastidious insides.

## CONCLUSIONS.

1. Helminth parasites in the alimentary canal and on the viscera of animals used for food are of frequent occurrence.

2. Occasionally they occur in the flesh of the animal, as in the well-known cases of trichina in pork, and the encysted stages of tape worms in beef and pork.

3. Many of the parasites found in mammals will develop in man. Only one species occurring in fish is known to develop in man.

4. Ordinary cooking kills these parasites.

5. Flesh which contains helminth parasites must not be confused with flesh in which insect larvae are develing, or which is "spoiled."

6. The flesh of food fish, especially of marine food fish, is exceptionally free from nematode parasites.

7. There has not been and there is not now any rational justification for the wholesale condemnation of any species of food fish on account of animal parasites.

8. The influence of the departments of health might well be directed towards encouraging the public to use such wholesome food material as the mussel, *Mytilus edulis*, and certain of the sharks and rays, now not much used for food in this country; assuredly they should not without certain knowledge use their power in such a way as to banish wholesome food from the market.

Naturally I should be most loath to criticize the action of any health officials, knowing how thankless is the task they have to perform in their efforts to care for the public health, and how their every act exposes them to criticism from some quarter or another.

But, as is evidenced in the action of the New York Department of Health in the matter of the butterfish, there may arise occasions wherein the interests of the public demand that the facts in the case be made known.

# THE RELATIONS OF COMMERCIAL AND SPORT FISHING—FAIR PLAY

By H. Wheeler Perce, *Chicago, Ill.*

Anglers should never lose sight of one very vital fact which confronts them in any efforts they may make toward the conservation of game fishes and that is the large importance and great value of the strictly commercial fishing industries.

At the same time the anglers are entitled, without question, to a proper consideration of their requirements and proper provisions for the continuance of conditions of a satisfactory nature. Good, clean, out-door sport is an absolute necessity in the making of good, clean citizens and is so recognized by all countries of higher civilization. In fact, the higher the civilization, the keener becomes sport and the more is sport appreciated and encouraged. In the greater nations of the world sport plays a conspicuous part and as the scale is descended, sport becomes less and less a factor in national life. By sport is meant healthy, invigorating, mind-resting recreation, involving physical effort in varying degrees, skill, the training of the muscles, the eye and the brain as well, along channels that would otherwise remain inert, and not mere amusement, the casual looking on at something which simply entertains, interests or excites. So-called "sport" involving gambling and its attendant feverish lust for "something for nothing" has no part in any consideration of recreative sport strictly as such. More especially is the need of true sport appreciated as our civilization and business activities become more and more intense and it is in our largest and busiest centers that men feel the greatest need of something that offers them relaxation from the strain. To very many men, angling is the ideal recreation and it is very likely no sport is as much beloved by its devotees, from the sturdy, bright-eyed boy with his penny hook, a pole cut in the

brush and a can of worms, to the grizzled veteran, the hero of many a tale, told and untold, with his delicate bamboo weapon of exquisite make and so many different patterns of beautifully tied flies that he has to consult a dictionary on the subject before he can tell you the names of them all. Probably there is no more democratic set of men on earth than is embraced in the fraternity of anglers. Rich and poor, high and low, the statesman and the "hired man," clergyman, lawyers, doctors, merchants, farmers, mechanics, clerks, all kinds and conditions of men "go-a-fishing" and all alike love the sport and love it more and more as their years increase. May and December rub shoulders in the fellowship of angling and the patriarch with silvery locks can be seen with his grandson at his side on many a stream or lake, both with eyes alight with the fires of enthusiasm.

And the sport is not only democratic but is essentially very widespread, for there is hardly a corner no matter how remote, of our beloved country, that does not contain its quota of anglers. If the census enumerators were to name them in their lists the legion disclosed would be a vast surprise to those who have given but casual thought to the subject. And this army of anglers buy things designed for their use, and catering to their needs constitutes no mean industry in this age of industries. Again, if the casual observer will give the matter thought, he will be surprised at the sum total in dollars spent by the anglers of this country on their sport, and every dollar spent by them means a dollar earned by someone else in supplying the wants of the angler.

The best of this is, that every dollar spent by the angler yields him an adequate return in improved strength, revived vitality, refreshed brain, keener faculties, clearer vision and better health. The only man who loses out is the doctor.

The angler was, is and always will be. He exists by nature, by precedent, by right and by choice. He is "born, not made." The character of his sport is cal-

culated to assist in making him a good citizen. Surely it takes him along "paths of peace" and "ways of pleasantness" and unfolds to him the loveliness of nature without a knowledge of which any man is "poor indeed."

The roystering rowdy, who goes on an alleged fishing trip as a cloak to a drunken revel is no angler. He is only a lying ruffian and sport for love of sport has no place in his sordid make-up.

The charge has been made that the angler kills his prey. True, and just so long as society kills in order that it may eat, just so long is the angler entitled so to do, provided he makes it his bounden duty and sees to it carefully, that every fish is eaten which he has killed.

It would seem a perfectly fair premise that the angler is entitled to his share of the best consideration and effort that our lawmakers are giving and making in the interest of all of the people, but he should always remember that others are entitled to their share as well.

While the presence of coarse fish, in some of the waters, seems to the angler a menace to his sport, and while they are a menace to some degree, he should always remember that many kinds of such coarse fish constitute a cheap food product, always a desirable thing, particularly with food stuffs soaring higher and higher in cost.

The fishing industry is something of very considerable importance, and, when measured in money, runs up into millions. This means work and wages for men, shelter, clothes and food for them and their families. It means industry and thrift and all that goes with intelligent labor, rightfully applied in developing the resources of nature. It means business and profit, enterprise and progress.

It ranks in character with farming, mining, manufacturing, merchandising, all the great basic things that mean so much in this great country, and around it should be thrown all the protection that the wisest minds and most beneficent laws can give. If the commercial fisherman in a spirit of larger enterprise is liable to overstrain

the resources of nature, he should be protected against himself. By the very nature of the thing, fishing is different from other industries in that the individual can do great harm to others by unwisely and excessively drawing upon the source of supply.

If a farmer overstrains his land—he alone suffers—but the waters are so undubitably a community interest that certain restraints are necessary in order that all may benefit and what is now a source of profit to all be not rendered barren for all. The seeds planted by a farmer yield a harvest at the point of planting, but fish planted, so to speak, at one point may be harvested miles away and hence it becomes the province of the state to do the planting or stocking and to the fisherman is left but the harvesting.

He should never forget this fact and should conscientiously respect and obey the wise injunctions against undue depletion of the waters. The fishing industry has the dignity of being probably man's oldest calling, it secures a valuable food for the people, it has its literature, its stories, its songs and legends. It is respectable and should be honored by all, and in no less a degree should those engaged in it remember the rights of others than industrial fisherman.

The angler should always respect the rights and privileges of the commercial fisherman, and he, in his turn, should render no less consideration to the rights of the angler.

And the law maker: He has a dual responsibility and should never fail in giving of his best in the interests of all concerned. Paternalism on the part of the state, may have its defects—certainly it has its limitations—but in the conservation of such natural resources as are offered by the waters of a state, paternalism, in some degree, becomes a necessity, if the best results are to be obtained. Such paternalism should be wisely and carefully exerted with an eye to the rights and requirements of all. No law maker should, through a desire to conciliate some small and selfish part of his constituency, stand in the

way of a wise enactment in the interest of the many. It may be hard, it may even seem right to him and to those who urge his mistaken course—but his mind should always remain open to the logical appeal of the many as against the clamor of the few.

Let the entire fish situation be placed on a plane of fair play. Let the angler demand and receive fair play and at the same time, play fair himself. Let the commercial fisherman demand and receive fair play and himself play fair in return and let the law maker play fair and see to it that every one, as far as possible, and consistently with his rights, gets fair play.

# MORE ABOUT THE PADDLE-FISH

(*Polyodon spathula*)

By M. L. Alexander.

*President, Conservation Commission of Louisiana, New Orleans, La.*

Further experiments with this species, commonly called "spoon-bill cat," were carried on in White Lake, La., during March, 1915, by E. A. Tulian, Superintendent of our Fisheries Department, in compliance with instructions issued by the Conservation Commission of Louisiana. These studies were made more especially with a view to obtaining more knowledge of the spawning season and habits of this fish; and whether it could be safely and successfully held in retaining ponds during this season.

Owing to various conditions over which the Commission had no control, we were obliged to make these studies on rather a more limited and economical basis than we had originally intended. Because of this, the work was somewhat less thorough and efficient than it would otherwise have been. At the same time, however, we consider the information gained as being rather instructive and valuable. Therefore I have decided to briefly outline this work to you and trust that it may be found of some little interest and use to the members of the American Fisheries Society, and others interested in fish culture and fisheries matters in general.

During the latter part of February and fore part of March of this year, the temperature of both weather and water averaged very much colder throughout Louisiana than was usual for this period. As a result the temperature of the water in White Lake did not exceed 62° Fahr. until after April 1st. From the 5th to the 8th of March, inclusive, the weather averaged somewhat warmer than later in the month. The water temperature for this

period stood at 60° Fahr. On the 9th it dropped to 50° and remained at this temperature until the 13th, when it slowly began rising. From the 14th to the 31st, inclusive, it ranged mostly between 58° and 62° Fahr. This excessive cold had the effect of retarding the spawning season at least two weeks beyond that of a normal season.

Our first day's fishing this year, March 6th, resulted in the capture of a considerable number of this species. Among these were eight females containing eggs, and three unripe males, but no spent females or males. One of the females contained mature eggs which were seen to be running from its vent when this fish was lifted from the seine into the boat, and as it flapped about in the boat before it could be transferred to the live car. This was witnessed by Capt. Fred Portie of Grand Chenier, La., who lifted the fish from the seine, Mr. Ernest Barbe of Lake Charles, La., and Mr. E. A. Tulian of our Commission. Two of the males would have matured within the next few days, and one of these was killed and cut open with the hope of obtaining sufficient mature milt with which to fertilize the ripe eggs, or a portion of them at least. However, the milt was found not to be sufficiently advanced for this purpose. The matured female and two others with eggs, as well as two immature males, together with several others were later tranferred to an enclosure for further observations.

Our second and third day's fishing was on the 9th and 10th. Among the day's catch two spent females, eleven unripe females and three males not yet matured, were found. Both the immature females and males were transferred to our enclosure to be held.

From March 1st to the 10th, inclusive, there was such continuous heavy wind that our seine could only be hauled on the three days mentioned above. After the 10th, for various reasons, no further seining operations were attempted until the 22d.

Fishing operations were resumed, however, on this date, and among the catch of that day were found two

females from which the eggs ran freely as they were lifted from the seine into the boat, and one ripe male from which the milt could be stripped. These fish were taken from the seine by Capt. Oliver Vaughn of Lake Arthur, La., but Mr. Ernest Barbe of Lake Charles, La., also saw both milt and eggs as they came from the fish. Unfortunately Mr. Tulian was detained at our headquarters in New Orleans on this date and as none of the employees on the ground understood the method of artificially fertilizing and hatching fish eggs, the matured milt and eggs could not be utilized. However, the three fish were transferred to a very small enclosure and held until Mr. Tulian's arrival, three or four days later, when he immediately examined them and found all three spent.

Because of continuous heavy winds the seine could not be hauled from the 22d until the 26th. On the latter date, however, seining operations were continued and resulted in taking seven spent females and six spent males, one female with mature eggs running from its vent, and two unripe males. For various other reasons, and owing to bad weather and the fact that no immature females had been taken during the day we decided to suspend further fishing operations.

The Superintendent of our Fisheries Department and a couple of other employees remained at White Lake until afternoon of the 30th. During the last days there, the fish which had been transferred alive to the enclosure at our camp were caught and a number of the more desirable specimens killed and opened. Every fish which had been empounded, except one, was found alive and in fine condition; the only external injury observed being a slight wearing away of the tail or a few minor scratches on the bill of three or four specimens. Twenty of the fish taken from the enclosure had been confined there twenty-three days. The roe of the unripe females and organs of all the fish opened were perfectly healthy and sound. Among these were a couple of immature males whose milt was absolutely healthy and normal.

The condition of these fish after so long a confinement is, I think both interesting and significant, inasmuch as it has been generally understood, I believe, that the paddle-fish when empounded in an aquarium or artificial pond usually lives only a week or ten days. We look upon the results attained as favorable indications that it probably will be possible to hold immature female and male paddle-fish until ripe, in properly constructed ponds, and then strip, fertilize and hatch their eggs artificially.

Judging from the experiments we made last year and again this, it appears quite certain that paddle-fishes work in schools when in the act of depositing and fertilizing their eggs. During the middle of the spawning period, a seine will invariably take a number of both mature and immature females and males, as well as recently spent ones, whenever any spawners are located by it. It has further been definitely ascertained that in White Lake during this period these fish are only to be found where the bottoms are of a somewhat hard and sandy character. Only an occasional fish could be taken when the seine was being hauled in localities where the bottoms are of a softer character. These are usually found in the bays and along stretches of straight shore-line.

The only fish we had to handle this year were those caught by an outfit and crew hired especially to catch paddle-fish for our operations. Therefore our studies were conducted with a very limited number of fish as compared to the number we secured last year when we were supplied by the commercial fishermen. This was caused by the fact that our close season on this species now extends from January 1, to July 15, of each year, therefore all commercial fishing is suspended.

The condition existing this year made it a rather expensive proposition to our Commission, and this contributed to further curtail the scope of our experiments. However, it is our intention to again conduct experiments next year, and on a more extended scale. At that time, we will probably also extend our field of operations so as to take in additional territory. Lake St. John in Con-

cordia Parish, this State, is possibly as well, or even better stocked with paddle-fish than White Lake. The fish grow considerably larger here, and, it is thought likely, spawn later as this lake is much further north than White Lake.

Another element which added to the curtailment of our experiments was the conditions found in and around the large enclosure where we empounded the fish. These were such as to make it almost impossible to get them out for examination from the day they were put into it until they were finally fished out at the close of the season.

While at work at White Lake, our employees obtained and preserved a few rather interesting specimens. Among these was the egg sac, etc., of a ten-pound female paddle-fish, caught when in the act of spawning. This still contained a portion of the mature eggs, some of which were in the oviduct. Another specimen is the egg sac, etc., of a female of about the same weight which was also depositing eggs when caught and which still held a few mature eggs. All of the internal organs of an eight-pound female which had just recently finished depositing her eggs, as well as those of a twelve-pound spent male, were preserved. The milt, etc., of an eight-pound unripe male was also preserved.

I attach herewith copy of a report on a microscopic examination of the stomach, etc., of a paddle-fish, made for us by Percy Viosca, Jr., B.S., of Tulane University. This, I think, may be found interesting and useful.

NOTE ON THE VISCERA OF *POLYODON SPATHULA*

Specimen—8 lb. female, after spawning, caught at White Lake, March 28, 1915.

Gill rakers long and numerous: clean and practically free from microscopic organisms. Only one copepod observed.

Stomach large (U-shaped). Contents, examined under compound microscope, found to contain: Protozoa (one large flagellate especially numerous), small

crustaceae (copepods and the like), filamentous algae, cyst-like bodies (probably protozoa or spores of algae).

Duodenum (small intestine), two inches long. Receives ducts of liver and pancreas and in addition, the duct of the appendices pyloricae. The latter are confluent in this species, into a single large, lobose diverticulum which opens by a single duct near the pyloric valve. It contained some of the same contents as the duodenum. It has doubtless been formed, phylogenetically, by several smaller pyloric caeca becoming confluent at the base.

Colon (large intestine), four inches long. Possesses a well developed spiral valve.

# EFFORTS TO RIPEN STRIPED BASS, 1915

By J. P. SNYDER, *Supt. U. S. Fish Hatchery, Cape Vincent, N. Y.*

Last spring Mr. John Fitzhugh decided to try to ripen striped bass at his slide in the Roanoke river near Weldon, North Carolina. At this slide each year the female fish captured would furnish more than a hundred million eggs could they be held in confinement and ripened. To this end Mr. Fitzhugh built a suitable and comfortable houseboat for the use of his watchmen and anchored it to the slide. He also made a live-car about 12 ft. long by 4 ft. deep and 4 ft. wide. This he fastened to the side of the houseboat. This car was built of 7/8-inch pine boards and was made watertight with the exception of a couple one-inch holes bored in the ends of the car. Over these holes he tacked fine wire cloth as some one told him he would have to keep out of the car the little eels that ascend the Roanoke river in vast numbers during the month of May. No provision was made for the transfer of the fish from the slide to the live-car with as little injury to them as possible, so they were permitted to kick around on the slide until they had weakened sufficiently to permit their being picked up by the gills and in that way carried to the live-car. As watchmen he had two negroes.

These fish begin spawning as soon as the water reaches 68 degrees Fahr. and usually the most and best eggs are taken within the first 48 hours after that temperature is reached. This occurred last spring on April 25th and during the last week in April twenty large female bass, together with a lot of males, were placed in the car. More bass were available but there wasn't room in the car for all that were taken. Yet in spite of these very unfavorable conditions four of the bass ripened. One of those that ripened cast its eggs in the live-car. The eggs from one turned out badly as only

about 25% of them produced fish. From the other two —one that ripened after being in the car 12 hours and one after 24 hours confinement—more than two million good eggs were taken and fertilized with milt from male fish held in the car. Most of the fish penned, however, developed fungus and soon died.

I arrived at Weldon on May 2d and the next day visited Mr. Fitzhugh at his slide. I found the water in the car very filthy as there was no circulation through it. As it was too late in the season to build a suitable car of slats with rounded edges we cut out part of each end of the car and over the openings thus formed we tacked wire cloth. Suitable nets or netting for handling these fish alive cannot be purchased at Weldon so we got a large piece of burlap out of which we made a net for handling the fish in the live-car and just back of the water rushing through the slide we placed another large piece of burlap. This piece of burlap was kept damp by spray from the swiftly moving water and large fish coming upon the slide were immediately wrapped in it and in that way carried to the live-car. At that time the water in the river was very low, clear and warm, registering 76 degrees; too warm to get the best results with these eggs and too low for fish to get above the slide so that but ten female fish were available for tests during my detail of two weeks there. The result of these tests are herewith presented in tabulated form and further explained in the "remarks" that follow. No tabulated data was kept of the tests made before my arrival.

REMARKS.

(a) I examined this fish at 10 a. m. May 10th. At that time she seemed soft enough to be ripe but no eggs came from her. At 3 p. m. on the same day Mr. J. E. Moody and I examined her and found her ripe and that she had already cast about half her eggs. The eggs remaining in her were taken and fertilized with milt from male fish that had been held in the pen. After

## EXPERIMENTS IN RIPENING STRIPED BASS AT FITZHUGH'S IN ROANOKE RIVER NEAR WELDON, N. C., 1915

| Date | Test No. | Size of Fish | Time of Capture | Condition when Captured | SUBSEQUENT EXAMINATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Time | Condition | Time | Condition | Time | Condition |
| May 7 | 1 | 7 lbs. | 6 a.m. | Fairly soft abdomen | May 8 9 a.m. | No change | May 10 10 a.m. | Sick and later died | | |
| 7 | 2 | 20 lbs. | 7 p.m. | Hard abdomen | do | No change | do | No change | May 11 9 a.m. | Hard. Showed signs of sickness and was removed |
| 8 | 3 | 8 lbs. | 6 p.m. | Soft abdomen | May 9 3 p.m. | No noticeable change | May 10 10 a.m. | No change died late in afternoon | | |
| 8 | 4 | 7 lbs. | 3 p.m. | Very soft abdomen | May 10 10a.m. | Very soft | May 10 3 p.m. | Ripe. Had already cast about half its eggs. See remarks (a) | | |
| 9 | 5 | 20 lbs. | 10 a.m. | Very hard | do | Hard | May 11 9 a.m. | Hard | May 12 3 p.m. | Hard and was taken from car |
| 9 | 6 | 30 lbs. | 5 a.m. | Very soft | May 10 3 p.m. | Apparently nearly ripe | May 10 9 p.m. | Ripe. See remarks (b) | | |
| 10 | 7 | 8 lbs. | 11 a.m. | Very soft | May 11 9 a.m. | Very soft | May 12 9 a.m. | Ripe. See remarks (c) | | |
| 10 | 8 | 7 lbs. | 3 p.m. | Very hard | do | Very hard | do | Very hard. Was taken out of car | | |
| 10 | 9 | 7 lbs. | 9 a.m. | Hard | May 12 9 a.m. | Hard | May 13 Noon | Hard | May 14 Noon | Hard. Was taken out of car |
| 11 | 10 | 40 lbs. | 1 p.m. | very soft abdomen almost ripe | May 9 3 p.m. | Sick. See remarks (d) | | | | |

they were expanded they were taken to the hatchery. They turned out to be a fine lot of eggs and produced a good percentage of fry. The fry were normal in every way.

(b) This fish was caught in a net by Mr. W. H. Clanton. She was placed in the boat and immediately taken to the live-car. I examined her at 3 p. m. and found her very soft. At 9 p. m. I again examined her and found her ripe, seemingly just right. A half hour later Messrs. Henry Grant and J. E. Moody and I took her eggs. Unfortunately in cutting her open Mr. Moody cut too deep and opened the membranes containing the eggs and the fish in her struggles lost most of the best eggs in the boat, while quite a little blood got in the pan with the eggs that were saved. The milt from several male fish was used but only about 25% of the eggs expanded and only about 10% of these produced fish. Those failing to expand seemed normal in every way. They separated nicely and were normal in size and color but showed no signs of expanding even though they were given every chance to do so.

Mr. Roberts reported that only a small percentage of the eggs taken from a large fish at Fitzhugh's slide on May 28th expanded. He knew of no reason for it.

Four years ago Mr. Walter Harrison caught a large ripe fish in a net and although the eggs seemed in perfect condition they would not expand. Other fishermen have reported this same condition.

(c) This fish was examined by me on May 11th but no eggs came from her. The next day she was examined by Mr. B. M. Camp who reported that she had ripened and had already cast almost all of her eggs. Mr. Camp has had long experience in taking these eggs and I have every reason to believe what he told me. This verified what little experience we had last season.

(d) The fish came upon the slide at a time when no one was there to remove her to the box and before being put in the box or car she had badly bruised herself on the slide. Two hours later I examined her. She was

nearly ripe, but sick and soon died. I am convinced that had she been placed in the live-car soon after coming on the slide she would have ripened. There were a number of large fish caught previous to my arrival at Weldon that undoubtedly would have ripened had the car had proper circulation and had the fish been removed to it without injury.

I might mention here that one million five hundred thousand eggs taken from a fish caught by Mr. Henry Grant were fertilized by milt from male fish held in confinement. Otherwise these eggs would have been lost as no other male fish were available at the time.

None of the tests were ideal as all the fish, male and female, were held in one live-car and it was impracticable to examine any one fish without seining up the whole bunch. This was injurious to them for in their struggles in the net their sharp spines cut each other and fungus soon developed, other unfavorable conditions were the frequent handling of all of them to keep track of the condition of one or two nearly ripe, the continuous presence of men around the car which was fastened to the house boat, and the small depth of water in the car, but two feet.

RECAPITULATION.

1. Seven of the thirty fish penned ripened in confinement.

2. All of these seven had very soft abdomens when penned.

3. The eggs from three of these gave splendid results, comparing favorably with the results obtained from eggs taken from ripe fish caught in nets.

4. The eggs from two others produced a low percentage of fry. This was disappointing, but the same thing has often happened with eggs taken from fish caught in nets.

5. Two of the fish ripened and cast their eggs between examinations. In confinement they cast their eggs within a few hours after ripening. This makes

by themselves so that they can be examined frequently without disturbing those not quite so far advanced. This we were not prepared to do.
it necessary that all fish nearly ripe be placed in a car

6. None of the hard or green fish, that had hard firm abdomens when caught, ripened or showed any signs of ripening in confinement.

## CONCLUSIONS.

1. Striped bass nearly ripe will ripen in confinement.

2. The eggs from some of those that ripen in confinement will produce good results.

3. Striped bass that ripen in pens cast their eggs within a few hours after ripening.

4. All or nearly all the eggs ripen at about the same time.

5. Milt from male striped bass held in confinement seems as potential as that from fish not confined.

# THE FISH FARMER IN ACTION

SNAP-SHOTS BY BUX.

One who lived in a great city and had waxed fat, not by iniquitous appropriation of the unearned increment of which he found himself unable to deprive his landlord, but solely by means of the legitimate 25%, which he lawfully collected from his service to his fellow men in buying and selling the necessaries of life, read a scrap of paper during one of those moments of seclusion from the world, which offer all from kaiser to peasant an opportunity to improve their minds, and what he found recorded seemed good to him. That he should thus have read when another might have simply done the other thing shows him a man who knew an opportunity when he saw it. So when he read that a fish might yield 9,000,000 of eggs at one delivery he said, "Why bother with a paltry 25%? Back to the land for me and put it under water as soon as I get there."

So he bought him a farm and dug him a pond and when the rain had filled it he dumped in all the fish, his congressman friend could get a paternal government to provide. Then with a stub of pencil and the back of an envelope he sat down to figure and to wait. He is still waiting, and the envelope is fuller of figures than the pond is of fish.

STOCK FARMING.

But enthusiasm is contagious and his farmer neighbor beholding said, "I will go and do likewise," as it is the way of farmer neighbors to say and to do. "But why bother to build a fish pond? I have a wood-lot where no grass is and there is no underbrush nor low limbs but much shade, and fresh air abundantly. I will fence it tight and into it turn my breeding stock of cattle and they will be no more care to me than my neighbor's fish are to him. I may not get 9,000,000% but 100 or even 50 are as much as a conscientious farmer ought

to desire when he has only to wait instead of working for it." Having to calculate the probable expense of reshingling his hog-pen he did not waste envelopes and wear out his mind trying to figure up the result to be expected from the wood-lot experiment, but determined simply to wait. He too is waiting still, not having found out that the cattle are dead.

### "SEE THE FARMER SOW HIS SEED."

Said another: "Two bushels of seed are enough for my field, but I have other things to do than to scatter it, and moreover the wind and the rain do that and every living thing from the chick just hatched to Old Scratch himself takes a dig at what I plant, so I will just empty the sack in the middle of the field and save myself much work."

But the harvest was slender, for lo! most of the field had no seed and where the seed was the plants crowded one another to death.

### THE ROUNDUP.

The season being come a ranchman went forth with his helpers to drag home by the tail his cattle and calves. But many difficulties arose and progress was slow. So he said, "Nay let us rather build a corral at the spring and when the cattle come to drink we will shut them in." And they did so and gathered them all without tearing up the turf and without damage to any tails. And an honest fish farmer, seeing, said to himself, I will gather my stock where they wish to be and will no longer set myself in array against them. But because they did not go down to the spring to drink he must find other causes and times and places for their gathering, and when he had found them he shut them in. *Verbum sat sapienti.*